Exploring cotton's mysteries

Since 1891, NMSU researchers have been toiling in cotton fields, studying ways to improve fiber quality and yield. Though it may seem at odds with their goal, sometimes they contaminate cotton plants on purpose.

The researchers have actually infected different cotton varieties with bacteria, fungi and nematodes to see which are susceptible to particular diseases.

It's a modern-day example of survival of the fittest. "The plants that fight it off are keepers," says Cindy Waddell, a senior research specialist with NMSU's Agricultural Experiment Station.

"We concentrate on those, collect the seeds, and plant them to test them again."

Next, the fiber is harvested and tested at the state-of-the-art cotton fiber analysis laboratory in Skeen Hall, on the west end of campus. Waddell says almost 200 experimental lines of cotton from NMSU's breeding program and about 40 commercial varieties from seed companies are tested here each year.

Fiber strength, length and fineness tests are conducted in the humidity- and temperature-controlled fiber laboratory. The temperature in the lab must be kept at 70 degrees Fahrenheit, plus or minus one degree. Humidity is kept at 65 percent, plus or minus 2 percent.

Humidity control is especially important for measuring fiber strength and elongation. "In a more humid environment, the cotton will absorb moisture and stretch a little more," Waddell says.

Fiber strength is defined as the force required to break a bundle of fibers. The greater the force required, the better the cotton quality, because stronger fiber can endure more vigorous mechanical handling in yarn factories.

Combing cotton: Students Angela Silva and Henry Gatica, Jr. measure cotton fibers in NMSU's fiber analysis laboratory. Silva, a senior, has worked in the lab since she was in high school. Gatica, a junior from Venezuela, is a second-generation lab employee whose father once was a graduate student in the cotton breeding program.

Length is measured optically with a narrow beam of light. "The longer, the better," Waddell says. "Fiber length helps determine the cotton's commercial value, because longer fibers make finer yarns and softer fabrics."

The length test begins with a comblike machine that selects a random sample from a series of small, staggered tufts of cotton. This assures fiber selection from the entire sample, which could have a variety of lengths.

"Our good stuff is about 1.25-inches long," she says. "Pima fibers are especially long—about 1.5 inches, and they're the softest things you can imagine."

To measure cotton's fineness, a fiber sample weighing 3.24 grams is compressed and air is forced through it to calculate airflow resistance. Maturity is determined by measuring fiber diameter and the volume of the compressed sample.

Next door to the fiber lab, research specialist Yingzhi Lu works in the cotton genetics laboratory. She says researchers here are trying to improve breeding lines and develop varieties with improved traits. Lu says molecular biology technology is fairly new in cotton research, but it's playing a bigger role.

"Reaching the level of using certain genes to control certain traits in cotton is still far away in the future," she says. "Cotton is different from other plants in that its DNA is more difficult to extract."

To map cotton genes, Lu extracts DNA from the new leaves of cotton plants, which have high DNA content. The leaves are ground and the DNA is extracted with solutions in small tubes. "We incubate the samples and several solutions under different conditions and temperatures," Lu says. "They might be warmed, cooled or kept at room temperature."

The samples are placed in a centrifuge, which produces DNA pellets. "The DNA is then quantified using fluorescent dye and a small instrument called a fluorimeter," she says. "The fluorescent dye attaches itself to the extracted DNA."

Next, small samples are amplified and then separated with a sequencer. "It identifies very minute samples," Lu says. "And it works quickly. We can identify almost 100 samples on the sequencer in 1.5 hours."

Waddell says the research done in NMSU's cotton labs keeps growers and manufacturers happy. Keeping consumers happy is a different story. "If we could get cotton strong enough to avoid wrinkles in the fabric, we'd have it made!" she says, with a laugh.

Anna María Pérez-Wright

Waste not, want not

When it comes to the cottonseed hull, the adage that one man's trash is another man's treasure may prove true. NMSU researchers are hoping to use cottonseed hulls to purify drinking water and wastewater.

"We're taking a substance that has little to no value and producing a high-value product from it," says David Rockstraw, NMSU associate professor of chemical engineering. The hulls are high-volume, low-value by-products of the cottonseed crushing process used to extract oil from the dehulled seed.

Rockstraw had success using a new process to convert pecan shells into activated carbon for use as a water purifier. He tried the same process, which involves treating the by-products with acid, on the cottonseed hulls. But the hulls didn't hold up as well as the pecan shells. "Too much of the material converted to ash, which is basically a by-product of the manufacturing process that we try to avoid," he says.

For now, Rockstraw is focusing on pecan shells and leaving the cotton hull research to scientists like Wayne Marshall, a research chemist with the U.S. Department of Agriculture's Agricultural Research Service. Marshall is conducting experiments similar to Rockstraw's, using different chemical modifications on the hulls. Marshall works with the Southern Regional Research Center in New Orleans as the lead scientist on a project to convert agricultural by-products into absorbents.

"Recent experiments have involved putting a positive charge on the surface of the hulls, so we can attract negatively charged material floating around in the water," he says. Marshall has been successful using the hulls to remove phosphorus from water, and he's running similar experiments to remove arsenic and selenium.

"The negatively charged ions we're particularly interested in are those containing arsenic," he says. "Arsenic is, of course, always toxic, and selenium, though it is a good antioxidant, can become toxic in high amounts."

Marshall says the point of the research isn't only to add value to waste material. "We want to do something beneficial for the environment as well."

Anna María Pérez-Wright

Hull-abaloo: David Rockstraw, NMSU professor, discovered a new way to treat pecan shells to create activated carbon and has experimented with using the same process on cottonseed hulls.

Cooking cotton

Baking cotton plants with blasts of air at 250 to 350 degrees Fahrenheit could provide a fast-acting alternative to chemical defoliants that has the added benefit of toasting insects responsible for sticky, hard-to-clean cotton.

The heat treatment recipe, developed by scientists with the U.S. Department of Agriculture's Southwestern Cotton Ginning Research Laboratory in Mesilla Park, calls for a tractor-pulled oven with an enclosed propane burner and motor-driven fan.

A one-row prototype has served up rows of crisp, brown cotton leaves in New Mexico, West Texas and California fields. Heat treatment produces faster results than traditional defoliants, which take up to two weeks to act.

"The cotton leaf is two cells thick, so this process cooks the leaves within 24 hours," says Paul Funk, an agricultural engineer with the Agricultural Research Service lab on the southwestern edge of the NMSU campus. The facility is one of three in the nation—along with USDA labs in Stoneville, Miss., and Lubbock, Texas—and the only one with a focus on irrigated, long-staple cottons grown in the West.

This fall, crews harvested Acala and Deltapine cotton at NMSU's Leyendecker Plant Science Research Center to pinpoint an optimal temperature for heat treatment. Control plots were treated with conventional defoliants that allow farmers to harvest the highest percentage of mature cotton in a single pass through the field. Defoliants stop leaf growth, open bolls and cause leaves to drop from the plants before harvest.

Heat treatment, in contrast, leaves foliage on plants, so scientists need to ensure that gins can get the fiber as clean as cotton from defoliated fields.

To find out, they ran seed cotton from heat-treated rows at Leyendecker through the ginning lab to compare it with fiber from defoliated plots.

"Through our partnership with textile researchers in the Cotton Quality Research Unit at Clemson University, we can follow the fiber all the way from the field through the spinning process," says Carlos Armijo, research textile technologist with the local lab. "We'll be able to provide comprehensive information about the fiber and find out whether heat treatment has affected the cotton's properties."

If heat-treated cotton passes muster in gins and textile mills, it could help solve a sticky problem of conventional defoliation. Defoliant-treated cotton seems to attract sucking insects, which secrete a gluey waste that can turn black and moldy, matting the fiber.

"People in the industry refer to it as sticky cotton. It's difficult to gin, and you cannot spin the fiber if there's too much stickiness," Funk says. "But the heat kills the aphids and whiteflies that live on the undersides of leaves."

Heat treatment also is an option for long-staple Pima cottons, which are difficult to defoliate chemically, he says. "Organic growers don't have any tools in their box for defoliation," Funk adds.

Because no crop dusters are used, heat treatment can be done on windy days. "We've tried it ourselves when we were too stubborn to wait, and wind didn't dissipate the heat," Funk says.

PAUL FUNK

Extra crispy cotton: Engineering technicians Tye Lightfoot, left, and Billy Armijo and tractor driver Orlando Morales test-drive a portable oven in cotton fields at NMSU's Leyendecker Plant Science Research Center near Las Cruces. Heat treatment may provide an alternative to traditional defoliation.

For further tests, scientists hope to develop a full-scale prototype capable of treating four to six rows at a time.

"The cost per acre is roughly equal between propane and defoliant, but the ground rig is more expensive to operate because of labor costs," Funk says. "A self-propelled machine could be the next step if it's feasible and economical."

D'Lyn Ford

What grows around, comes around

Cutting-edge cotton farming has come full circle as innovative grower Dosi Alvarez of La Union returns to farming's roots and grows cotton organically.

Alvarez, a third-generation farmer, began growing organically on just 25 acres in 1993. Today, New Mexico's first and only certified organic cotton farmer has gone totally organic, producing 450 acres of Pima cotton, 300 acres of alfalfa and more than 200 acres of chile.

"There's a good niche market for these crops," Alvarez says. "I can't grow enough organic cotton to meet the demand. This is the best year we've ever had—the cotton yields have far surpassed my expectations."

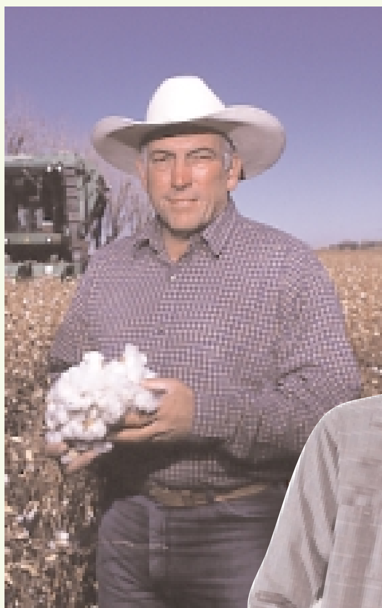
It takes three years of growing crops without chemicals—pesticides, herbicides or fertilizers—to certify a field organic. The farm is inspected annually by the state certifying agency, the New Mexico Organic Commodity Commission. Chief inspector Brett Baker says Alvarez stands alone farming organic cotton in New Mexico.

"Growing organically is still perceived as a big risk by farmers, especially because of the three-year period not using chemicals before you get certified, so that's a little scary," he says. "But Dosi has been a great example for others, showing that it can be done."

Baker not only inspects the farm to certify it as organic, he also examines the gin that cleans Alvarez's cotton, which is the last batch of cotton ginned. "They have to clean everything from top to bottom before they can gin the organic cotton," Baker says.

Much of the cotton Alvarez grew this year was used for products sold in the environmentally friendly *Patagonia* mail-order catalog.

"Environmentally conscious or chemically sensitive people really want organic products," Alvarez says. "I like the idea that my employees are happy, because they don't have to mess with chemicals. We all go home worry-free, because we're not exposed to these hazards."



Stylishly organic: Dosi Alvarez shows off the long-staple Pima cotton he grows organically. Alvarez is wearing a Patagonia shirt made from cotton he grew, which sells in the company's mail-order catalog for $70.

Alvarez, 50, is a self-proclaimed late bloomer who farmed traditionally for almost 30 years.

"I didn't get married until I was 39, and about a year later, when my son was born, I was so worried something was going to be wrong with him because of the chemicals I was using on the farm," he says.

That scare was enough for Alvarez to seriously reconsider using chemicals. He farms land his grandfather cleared with horses and knew he could learn a lot about chemical-free farming from old-timers, including Ramon Alvarez, his father; and Jose Melendez, who's been with Alvarez farms for more than 20 years. Controlling weeds has been one of the biggest challenges for Alvarez, and one of the most expensive.

"My dad taught me how to soup up a cultivator for good weed control, and I also use a weed burner," Alvarez says. "I was determined to do it and I made it work." But Alvarez admits that he misses using Round Up, referring to America's best-selling chemical weed killer.

Alvarez Farms also has turned to hoeing by hand. "Labor is one of our biggest expenses," he says. "On some fields, I might have a $30 per acre hoeing bill and on another it might be $100."

Alvarez says one of the major keys in organic farming is crop rotation, which breaks up the insect cycle. "That's a major way to control them," he says. In fact, Alvarez happily notes that his farm has become a haven for beneficial insects.

"Many conventional growers are amazed that we have done this and survived," Alvarez says. "But growing organically is great—I see only benefits in farming this way."

Anna María Pérez-Wright